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**INSTRUCTIONAL QUALITY INVENTORY:
USABILITY OF PROCEDURES**

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INSTRUCTIONAL QUALITY INVENTORY: USABILITY OF PROCEDURES

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The purpose of this effort was to evaluate the instructional quality inventory (IQI), which was developed to supplement the instructional systems development procedures used for training development by all three military services. A two-person team with limited experience in the IQI process used IQI to analyze an instructional module from the Radioman (RM) "A" School, and revised the module to correct deficiencies found. To determine the effectiveness of the revised module, two groups of students were selected.		

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The first group (standard) received the original materials; and the second group, the IQI-revised materials. Results showed that the IQI provided a useful framework for identifying deficiencies in current instruction and that students using IQI-revised materials scored higher on job-relevant tests than did those using standard materials.

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FOREWORD

This research was conducted under project Z1175 (Training System Design and Management), subproject PN.05 (Improved Effectiveness in Course Design, Delivery and Evaluation) and was sponsored by the Chief of Naval Operations (OP-115). The purpose of the subproject was to provide specific guidelines for development and evaluation of Navy instruction so that subjective judgments can be reduced. The purpose of the effort reported here was to determine whether relatively inexperienced persons can effectively revise instructional materials using the instructional quality inventory.

Appreciation is expressed to RMCs W. Straub, E. Sweat, and C. Hendricks, of the Radioman "A" School, Naval Training Center, San Diego, for their support in reviewing materials and arranging access to the student population, and to personnel of the Instructional Program Development Center, Naval Educational and Training Support Center Pacific, particularly Ms. S. Drummer and S. Scott, for developing final test materials.

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SUMMARY

Problem

The instructional systems development (ISD) procedures are used for training development by all three military services. Because of the complexity of these procedures, considerable skill is required in applying them. Therefore, to aid training developers, the Navy Personnel Research and Development Center has developed a methodology known as the instructional quality inventory (IQI), which is designed to "parallel and supplement" ISD procedures. To date, evaluation of the IQI has been indirect. More direct, quantitative evaluation is needed.

Purpose

The objectives of this research were to (1) determine whether relatively inexperienced persons could use IQI to identify difficulties in and revise instruction materials, (2) evaluate the effectiveness of the revised materials, and (3) determine costs of applying the IQI.

Approach

The optical character reader (OCR) module from the Radioman (RM) "A" School curriculum was selected for revision. This module is used to train RM students to verify information contained on DD Form 173, which is optically scanned for computer-based transmission. The computer rejects all messages that do not meet critical requirements as to spelling, punctuation, and character alignment. This module had been identified by instructors as needing revision.

IQI techniques were used to evaluate the then-current material. A two-person team with limited experience in the use of the IQI process analyzed the selected material, examining the objectives, testing format and content, and training materials. This resulted in (1) some changes to the objectives, which were found to be inconsistent with job requirements, (2) an entirely different approach to testing, and (3) a new set of training materials. During the process, lessonware development costs were tracked to allow for later cost analysis.

To evaluate the effectiveness of the revised materials, two groups of 30 students each were selected at random from the RM School. One group (standard) received the existing training and testing, which required that they meet test criteria at several stages of the training before they could advance. The second group (IQI) received the revised training, which allowed them to proceed at their own pace, taking self-tests to assess their progress. The performance of the two groups was compared, based on the scores achieved on the IQI test.

Findings and Discussion

1. The IQI provided a useful framework for determining deficiencies in current instruction. By examining module components in the sequence called for by the IQI, deficiencies could be readily identified and revisions made.

2. While applying the IQI, several problems were encountered. The most prominent of these is that IQI manuals direct the user to relate training to initial job skills, but they do not indicate how users are to obtain this information. Also, because of the many small details in IQI manuals, the user can be distracted from seeing the overall scope of the task

(e.g., ensuring a correct and complete set of objectives). One other relatively minor difficulty occurred in distinguishing between use-aided and use-unaided procedures.

3. The groups differed significantly on their test performance. IQI students averaged 57 percent correct answers, compared to 49 percent for standard students. The standard group had studied their materials for an average of 11.6 hours, compared to 2.8 hours for the IQI group. Thus, the IQI group scored somewhat higher on the job-relevant test than trainees in the standard group.

4. An important consideration in evaluating instruction concerns the costs incurred in the process. These were almost all in hourly costs for the research team, amounting to 1/5 of a man-year. However, it is estimated that this figure would be considerably reduced if IQI were applied concurrently with the ISD process and would be less as the team gained experience.

Conclusions

The findings suggest that the IQI material is more effective in producing job-relevant performance than the existing materials. How long it would take for trainees to learn to a high test performance criterion is not known. The fact that IQI trainees achieved as well as they did in 2 to 3 hours suggests that training time might be considerably less than that required currently for the existing materials.

Recommendations

1. IQI procedures should be used to increase the quality of instructional materials developed by ISD users and others.

2. IQI procedures should be revised to provide the user with (a) better tools to deal with the job relevancy issue, and (b) computer-based direction to facilitate completion of the many steps.

3. Future evaluations should be made in situations where learning conditions are controlled so that cost-effectiveness can be calculated.

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INTRODUCTION

Problem

All military instruction is presently developed in accordance with the interservice procedures for instructional systems development (ISD), which were conceived as an application of a "systems approach" for military and civilian training developers (CNET, 1975). ISD is a complex process, consisting of many sequential steps, requiring training developers to make many judgments as the process is applied. Because of the large number of judgments and the ambiguities in the procedures, the final instructional product can vary widely in instructional effectiveness and consistency with job requirements. To reduce this variability and ensure appropriate application of ISD procedures, the instructional quality inventory (IQI) (Wulfecck, Ellis, Richards, Woods, & Merrill, 1978) was designed. Although the IQI incorporates prescriptions derived from empirical research, little direct evidence exists as to how well people can use the procedures and the effectiveness of IQI revised instruction.

Purpose

The objectives of this research were to (1) determine whether relatively inexperienced persons could use IQI to identify difficulties in and revise instruction materials, (2) evaluate the effectiveness of the revised materials, and (3) determine costs of applying the IQI to provide a basis for planning.

Background

IQI is basically a logical method that uses sound principles of training and the psychology of learning and instruction to evaluate the quality of the three main products of instructional development--objectives, test items, and instructional presentation. It deals principally with cognitive and psychomotor instruction rather than attitudes and motivation. It is intended for use by people who are familiar with ISD, not by untrained personnel, and serves as a supplement to ISD. Since IQI assumes that what needs to be taught has been determined, its application depends upon a good task analysis or the availability of subject matter experts (SMEs), preferably both.

The IQI procedures are documented in four reports: an introduction and overview (Wulfecck et al., 1978), a user's manual (Ellis, Wulfecck, & Fredericks, 1979), a training workbook (Fredericks, 1980), and a job performance aid (Ellis and Wulfecck, 1978). IQI procedures include the following:

1. Since all ISD steps depend on careful specification of learning objectives, the first IQI procedure is to assure the adequacy of objectives. This is done by classifying each objective and judging whether or not it accurately reflects the intended student performance after training. Classification is determined according to what the student is required to do with the information he learns (remember or use) and what type of information the student is learning. Objectives are considered adequate if they meet the following criterion:

- a. They must have properly specified conditions, standards, and action. Conditions are the "givens" in a particular situation, such as a formula, a manual, job aids, tools, etc.; standards refer to performance levels and end products; action specifies the one type of activity sought in the objective (no more than one action verb per objective is permitted).

b. They must be uniquely classified on the task-content matrix. IQI requires that objectives fall into only one cell of a specially developed matrix that specifies the content type of the objective in terms of (1) requiring trainees to learn facts, categorize things, and use procedures, rules, or principles, and (2) what the task level is (i.e., whether the student is simply to remember the material or use it in some way).

c. They must be consistent with the job. In the past, classroom objectives were often made appropriate to the constraints of the teaching environment; their relationship to the job was often ignored or downplayed.

2. The next step is to ensure that tests accurately measure a student's progress toward objectives. This is done by assessing the consistency between test items and their associated objectives. Essentially, each test item must be classified in the same way as its objective. After test items and objectives are consistent, the adequacy of the test items is assessed.

3. The third step is to ensure that the instructional presentation(s) is (a) consistent with the objectives and tests, and (b) adequate according to psychological principles of learning (i.e., whether it will support student learning).

The IQI procedures were refined through the use of training workshops, where user difficulties were identified and procedures classified. However, little direct empirical evidence regarding IQI usability and effectiveness is available.

REVISION OF TRAINING MATERIALS

Training Development Personnel

A two-person team was formed from among researchers at NAVPERSRANDCEN who were familiar with ISD but not experienced in using IQI. Their intent was to determine whether the IQI procedures could be used to revise a segment of a Navy "A" School course that had proven to be unsatisfactory.

Training Materials Selected

The optical character reader (OCR) form module from the Radioman (RM) "A" School curriculum was selected for revision. This module is used to train RM students to verify messages already typed on DD Form 173,¹ which is optically scanned for computer-based transmission. The computer rejects all messages that do not meet critical requirements as to spelling, punctuation, and character alignment. Figure 1² illustrates a copy of the DD Form 173 currently in use. Although the form has been revised since the work described in this paper was completed, the requirements remain essentially the same.

¹On-the-job, RM graduates are required to type the message. However, because of the lack of equipment at the school, the ability to type the forms correctly could not be used as a classroom objective.

²Because of the large number of figures in this section relative to the amount of text, the figures have been placed at the end of the section, commencing on page 5.

The entire RM "A" School curriculum had been recently revised; however, students were having difficulty with the OCR form module, taking an average of about 11 hours' study time, including remediation, to reach criterion on the tests. Also, the school had received reports that students were unable to do this task properly upon assignment in the fleet.

IQI Analysis

As indicated previously, the team members had had prior training development experience but had not used the IQI. The team attended a two-day IQI workshop prior to the start of the project and had access to IQI documentation.³ Whenever a question arose, one team member first sought help from the other and then from an SME. On a few occasions, it was necessary to consult IQI developers to clarify an IQI application.

The team reviewed the instruction and consulted with SMEs in the school and a communications station to become familiar with the OCR form. Frequent and continuous consultation with SMEs was necessary during the IQI analysis to verify the correctness of materials, determine their relationship to the job, and clarify technical questions.

Objectives

The team started with an analysis of the objectives. This turned up minor but persistent problems. In most cases, the objectives lacked time standards and included two action verbs (only one action verb per objective is permissible). Also, provisions were not made to allow for the use of an alignment margin template, which can be used to check tab stop locations. These templates are available on the job and can be used easily. Objectives were revised to correct these deficiencies.

Test Items

The test item format is multiple-choice, since the Navy's computer-managed instruction (CMI) system used to run the individualized RM course allows only multiple-choice answer grading. Although the test items in the original OCR module are multiple choice, they are neither consistent with the objectives nor appropriate to the job. As can be seen in the examples in Figure 2, they are designed to test for facts, rather than for use-unaided procedures.

For the test item to be consistent with the objectives, a completed OCR form should be given to the student for verification as to proper spacing, character placement, spelling, abbreviations, and punctuation. This necessitated devising some procedure that would allow the use of the OCR form in conjunction with the multiple-choice format. Thus, in consultation with personnel from the Instructional Program Development Center (IPDC), a new testing format was designed that is as consistent with job performance as possible, given the multiple-choice testing constraint of the CMI system. Each test question is actually a completed OCR form with one or no errors, as shown in Figure 3. The student had to verify each section using an overlay to check spacing. He then had to indicate, using the multiple-choice format included on each form, the section in which the error occurred (there was no more than one error in a message) or that there was no error.

³At the time of the analysis, one team member was working on an IQI workbook, developing practice examples of IQI concepts (Fredericks, 1980). This may have resulted in a higher IQI skill level than for someone who had only taken the IQI course.

Instructional Presentation

In the original module, information was presented in narrative form, broken into various components (see Figure 4). After the student finished one component, he took a within-lesson test and moved on to the next. He never had any practice looking at OCR forms and finding any errors in them.

The revised training materials were designed to reflect job conditions as closely as possible, given the limitations of the school facilities. Since verifying the form is a use-unaided procedure, the task was divided into steps, the order of which followed the completion of the form from top to bottom. Each section of the form (e. g., address component, message text) was separated and identified, and parts within the sections (e.g., "From" line, "To" line) were separated. As shown in Figure 5, the parts were identified in the left-hand margin of the revised training materials. The most important verification check was located in the middle column (only one action for each check), and additional information was provided in a column on the right.

For each section of the form, the following was included:

1. Self-test questions for use in pointing out important points and helping the student focus his studying (Figure 6).
2. An example of a completed OCR form, with the errors identified (Figure 7). A checklist form was used, with the answers given for each part of the section (Figure 8).
3. A second example of a completed OCR form. This time, the student had to identify the errors using a blank checklist form. After he identified any errors, he could check another OCR form where the errors were identified as feedback.
4. A third example of a completed OCR form. This time, the student had to identify the errors with no checklist or aids, just as he would do on the job. After he identified any errors, he was shown the form with the errors corrected and an arrow pointing out where they were wrong.
5. More examples and practice were given the student as he went through the lesson. This was experience just like he would be getting on the job except it was in graduated steps--from using a completed checklist to a blank checklist to no aids when verifying the completed OCR form.

The revised materials reflect job orientation rather than the topic orientation of the standard lesson. Too many important points were embedded within details in the standard lesson. The revision tried to identify the important points for the student and isolate them into steps for verifying the OCR form.

Cost Analysis

Course revision can be an expensive process, especially when recently developed programs must be revised. To document the cost of revision, provision was made to track software development costs and examine training costs, if applicable. These costs mainly involved personnel. It was considered that costs of other categories, such as facilities and hardware, remained fixed for both the original training development approach and the IQI revision.

JOINT MESSAGEFORM										SECURITY CLASSIFICATION UNCLASSIFIED	
PAGE		DTG RELEASER TIME			PRECEDENCE		CLASS	SPECAT	LMF	CIC	ORIG/MAG IDENT
		DATE TIME	MONTH	YR	ACT	INFO					
01 of 01		041600Z	OCT	81	RR	RR	UUUU				2780800
BOOK		MESSAGE HANDLING INSTRUCTIONS									
<p>FROM: COMNAVTELCOM WASHINGTON DC</p> <p>TO: CNO WASHINGTON DC</p> <p>ZEN COMNAVSECGRU WASHINGTON DC</p> <p>INFG ED MOFFETT PRESIDENT</p> <p>COMMCORP</p> <p>WASHINGTON DC</p> <p>XMT NAVAUTODINSCEN ALBANY GA</p> <p>UNCLAS DRILL //NO2300//</p> <p>DD 173 MESSAGEFORM</p> <p>A. NTP 3 SECTION 2</p> <p>1. THIS FIGURE ILLUSTRATES CORRECT CONSTRUCTION AND TYPING OF THE DD 173 JOINT MESSAGEFORM.</p> <p>2. THE ENTRIES ILLUSTRATED ARE FOR A SINGLE PAGE MESSAGE, OF ROUTINE PRECEDENCE, WHICH IS UNCLASSIFIED AND INCLUDES AN ADDRESSEE WHO RECEIVED THE MESSAGE BY OTHER MEANS, A COMMERCIAL ADDRESSEE AND AN EXEMPTED ADDRESSEE.</p>											
<p>6</p> <p>5</p> <p>4</p> <p>3</p> <p>2</p> <p>1</p> <p>0</p>											
DISTR											
DRAFTER TYPED NAME TITLE OFFICE SYMBOL PHONE							SPECIAL INSTRUCTIONS				
S.B. DEAN, CDR, N-44, 3264, 040CT81							MINIMIZE CONSIDERED				
TYPED NAME TITLE OFFICE SYMBOL AND PHONE							SECURITY CLASSIFICATION				
D. DYER, S-3, N-4, 3244							UNCLASSIFIED				
SIGNATURE <i>D. Dyer</i>							DATE TIME GROUP		041600Z OCT 81		
<p>DD 173 2 (OCR)</p> <p>REF: JCS EDITION 5 OBSOLETE 4 9 0 02 15 000 1 135</p> <p>U.S. GOVERNMENT PRINTING OFFICE 1980-333 226 E 2193 32</p>											

Figure 1. Illustration of the DD 173 message form.

You may use NTP 3 SUPP-1, as necessary.

1. According to NTP 3 SUPP-1, the originator of the given DD Form 173:
 - a. Should read: COMSYSTORE KEFLAVIK UK.
 - b. Is correct; a correction is required.
 - c. Should read: "NAVY COMMISSARY STORE KEFLAVIK IC."
 - d. Is correct as it is typed on the message form.
2. According to NTP 3 SUPP-1, the INFO addressee on the given DD Form 173:
 - a. Should read: NAVEXHGSERCEN SAN FRANCISCO CA.
 - b. Is correct as it stands.
 - c. Is missing its geographical location; it should be added.
 - d. Should be listed on the message form using the long title.
3. The OPSIG "ZEN" is used by an originator to assure that:
 - a. The computer reads (accepts) the addressee that follows.
 - b. A message is delivered on a "Red" circuit.
 - c. A message will be delivered by another means.
 - d. The message is sent as a book message.
4. Which statement below is true about verifying the address component on DD Form 173?
 - a. The long title address of commands is used.
 - b. No punctuation is used in a plain language address.
 - c. "XMT" is used to ensure all members of a CAD receive a message.
 - d. The "FROM" address must fit into a maximum of two lines.

Figure 2. Examples of standard test items.

JOINT MESSAGEFORM		UNCLASSIFIED	
01 01 2952100 PP RR	UUUU	222337Z	OCT 81

FROM COMELEVEN SAN DIEGO CA

TO ALELEVEN

ALELEVEN 038/81

UNCLAS DRILL //NO1020//

CHANGE ONE TO UNIFORM REGULATIONS FOR THE ELEVENTH NAVAL DISTRICT

A. COMNAVBASE SAN DIEGO/COMELEVENINST 1020-2X

B. MODIFY PARA 3 OF ENCL {1} TO REF A {UNIFORM OF THE DAY} FOR MALE AND FEMALE OFFICERS AND MALE AND FEMALE ENLISTED {E1-E9} PERSONNEL TO INCLUDE AUTHORIZATION TO WEAR THE SUMMER BLUE UNIFORM DURING THE WINTER UNIFORM PERIOD.

C. REQUEST SOPAS PASS TO FORCES AFLOAT.

Instructions normally found prior to test

The following error statements correspond to the answer numbers on your answer sheet as shown here:

1	2	3	4	5	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	1 Error in Headerline Blocks
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	2 Error in Address Component
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	3 Error in Text
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	4 Error in Baseline Blocks
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	5 No Errors on Message

NOTE: THERE IS ONLY ONE ERROR ON A MESSAGE.

DIST.

D.F. DOBB3, LT, OPS, X225,
22 OCT 81

R.G. BURNHARD, CDR, ADM, X220

R.G. Burnhard

DD 173 (OCR)

UNCLASSIFIED 222337Z OCT 81

MESSAGE 7, TEST PACKAGE 2443

Figure 3. Example of an IQI test item meeting the multiple-choice criterion. In this case, the error is in the headerline blocks. The student must locate the section containing the error and mark the corresponding alternative on the answer sheet. (For illustration only, the mode of marking the answer is overlaid on the test OCR item).

Address Component

Now that we have talked about the headerline blocks and the baseline blocks, let's go on to the address component.

The short title address of any command or activity is always used here. These addresses are listed in the Plain Language Address Directory (PLAD), NTP 3, Supplement 1. Computers accept only the listed addressees, so the addresses must be correct. If there is any doubt, check the PLAD. The PLAD lists the long and short titles of activities and commands alphabetically, in this way:

Long Titles of Activities

Chapter 2. U.S. Navy
Chapter 4. Coast Guard
Chapter 6. Marine Corps

Short Titles of Activities

Chapter 3. U.S. Navy
Chapter 5. Coast Guard
Chapter 7. Marine Corps

Chapter 10. U.S. Navy Ships
Chapter 11. U.S. Coast Guard Ships

In Figure 8 shown on the next page you will see examples of long and short title listings from PLAD. Note how commands are listed in both chapters.

Figure 4. Example of original training materials.

Address Component

The OCR scans the address components to route the message. Addressees are stored in its memory, so the scanner must find the same characters as those stored in memory for proper routing. These addresses are known as "Plain Language Addresses" (PLA) and are found in the Plain Language Address Directory (PLAD) of NTP-3 (C), Supplement 1. You must remember the following information about each line:

	VERIFICATION CHECKS	CONSTRAINTS AND ADDITIONAL INFO
General Information	Check for extra punctuation. Check for correct numbers. Check for abbreviations.	1. PLAs have no punctuation. 2. Numbers must be spelled out. 3. States are abbreviated.
From Line	Verify PLA in PLAD. Verify PLA as that of drafter's.	1. Allowed one line only. 2. Cannot extend beyond tab 75.
To Line	Verify PLA in PLAD. Check indentation for continued addresses.	1. Addresses may be continued on two more lines. 2. Continued addresses must be indented five spaces to tab 31 so the scanner knows they are part of the same address.
Info Line	Check for pro sign INFO.	1. The first info addressee must be preceded by the pro sign INFO (no punctuation). 2. All other info addresses follow without the pro sign. 3. If there are no action addresses, the pro sign is typed over the "TO."

Figure 5. Example of IQI-revised training materials.

Address Component	
	a. Addresses must be looked up in the_____.
T	F Multiple addresses have punctuation.
	b. The from line contains the address of the_____.
	How many lines may this address occupy?
	c. How many addressees may appear on an OCR form?
	How can the computer tell if an address is continued on another line?
	d. How do you identify an INFO address?
	e. How do you delete part of a collective address?
	f. How do you identify an addressee that is to receive a message by means other than electrical?
	g. Messages sent to commercial addresses must be classified as_____.
T	F Commercial addresses may only extend for one line.

Figure 6. Self-test questions used in IQI-revised training materials.

JOINT MESSAGEFORM		UNCLASSIFIED	
1	01 3192030 RR	UUUU	152035Z NOV 79
<p> <i>A.1</i> → <i>A3</i> → COMNAVIRPAC (IFIC) SAN DIEGO CALIFORNIA <i>B.2</i> → <i>B.1</i> → COMASWINGPAC (IFIC) SAN DIEGO CA. <i>B.4</i> → <i>B.3</i> → INFO (NAV) PERSRANDCEN SAN DIEGO CA <i>B.7</i> → <i>B.1</i> → DESRON (7) B.1 <i>C.17</i> → XMT COMPATWINGSPAC MOFFETT FIELD CALIF (CONFIDENTIAL) DRILL //NO3900// DASS/DTS DATA GATHERING 1. REQUEST TAKE REF A FORAC AS APPROPRIATE. DIRLAUTH (A.) NAVPERSRANDCEN SAN DIEGO CA 131705Z NOV 79 <i>C.2</i> </p>			
<p>6 5 4 3 2 1 0</p>			
OCR message #1. Example with errors.			
<p> 0 S.B. DEAN, CDR, 44, 3264, 15 NOV 79 001 003 D. DYER, S3, 24, 3244 D. Dyer DD 173 UNCLASSIFIED D.67 152035Z NOV 79 </p>			

Figure 7. Example of OCR form with annotated errors.

Verifying Address Components

Verifying addresses is one of the most important functions you will perform as a novice RM. Check the previous section on address components if you do not remember all the information you need to verify. Use the template to ensure correct alignment and spacing and the PLAD to ensure correct addresses. After you become familiar with these addresses, you will be able to recognize them from memory. Use the same OCR form to verify the steps given below.

- No 1. Punctuation is correct.
- No Numbers are spelled out.
- No Appropriate abbreviations are used.
- No 2. Drafter's PLA is correct.
- No 3. Addressees' PLAs are correct.
- No 4. Info pro sign correct.
- OK Info addressees' PLAs are correct.
- OK 5. Collective addressees' PLAs are correct.
- OK XMT pro sign correct.
- NA 6. ZEN pro sign correct.
- No 7. Alignment and spacing correct. *Double space before DESRON*

Figure 8. Completed checklist form for OCR form shown in Figure 7.

EVALUATION OF REVISED MATERIALS

Subjects

To assess the effectiveness of the revised materials, two experimental groups of 30 students each were selected at random from the RM "A" School. One group was called the IQI group and the other, the standard group. To assess potential prior differences in the groups, their Armed Services Vocational Aptitude Battery (ASVAB) test scores were compared. Analysis of these scores (see Table 1) showed they were similar except for the AFQT score.

Table 1
Student Characteristics

Mean Scores							
Groups	AFQT	Numerical Operations	Attention to Detail	Word Knowledge	Arithmetic Reasoning	Math Knowledge	Mechanical Information
Standard	61.8	53.1	52.3	55.4	53.1	52.1	49.6
IQI	55.6	54.0	53.1	54.3	51.6	51.7	49.5

Learning Conditions

The standard group was trained to verify messages on DD Form 173 using the original OCR module. Their training procedures are listed in Table 2. They had to meet performance criteria (on test items similar to those shown in Figure 2) before they could advance. All training was individualized, with students working in large study areas under the supervision of several learning supervisors. Within 1 or 2 days after they completed the OCR module successfully, they were administered an 11-item IQI test. Each item consisted of a completed OCR form, which was either correct or contained one or no error (similar to Figure 3). Students had to complete the multiple-choice test format for each item.

The IQI group was trained using IQI revised materials approximately 2 months after the standard group. These students were selected randomly from the same RM school population just before they were ready to start the OCR module. A nonschool chief petty officer (CPO) explained to the students that they were being given a different version of the OCR module. All training was done in one of the regular study areas under the CPO's supervision. Upon completion, the IQI group was administered the IQI test (see Table 2). Since the RM School would not agree to substitute the revised OCR materials for the original materials as far as class completion credit was concerned, the IQI group also had to take the regular within-lesson and final module tests.

The IQI test was used to assess the performance of the two groups because it was designed to be consistent with the revised objectives and with the job, which was not true of the standard module examinations. Because of this distinction, performance on the IQI test provides a basis for comparing the groups that reflects the potential for job performance.

Table 2
Training Procedures for Instructional Evaluation

Group	Instruction	Study Procedures
Standard	Standard CNET approved self-study narrative or programmed instruction (PI) with mandatory within lesson tests.	<ol style="list-style-type: none"> 1. Student studies either form of lesson until ready to take sublesson test. 2. If student fails, repeat either narrative or PI up to three times until test is passed. 3. If student passes, go on the next sublesson, and repeat procedure. 4. Upon completion of the sublessons, the student takes a self test. 5. When satisfied with the results, the student takes the final full lesson test. 6. One or 2 days later, the student takes the IQI test.
IQI	Experimental self-study narrative with self tests.	<ol style="list-style-type: none"> 1. Student studies and takes sublesson self tests. 2. When satisfied, student goes on to next section, and repeats procedures. 3. Upon completion, takes IQI test.

Group Performance

The mean percent correct for each group on the IQI test is shown in Table 3, along with the average number of hours taken to study the OCR module. As indicated earlier, the two groups differed on the AFQT score.⁴ To correct for this difference and to increase the precision of the test score measures, a one-way analysis of covariance was performed on the data. When corrected for differences in AFQT scores, the IQI student test scores were significantly higher than the standard group.

The obvious and large difference in mean study time shown in Table 3 for the two groups is misleading. The groups were studying under very different requirements. As noted earlier, the standard group was required by the school to learn materials and take intermodule tests that were not closely job-related. The IQI group was measured solely on the time taken to complete the IQI materials. These conditions probably produced most

⁴The difference in AFQT scores may be a function of the lapse in time between group testing--students entering the Navy at different times of the year tend to have different aptitude levels (BUPERS, 1980).

of the difference in study time. It is not unusual to be unable to run approximately matched groups in naturalistic settings, but it does limit the generality of the results and weakens the conclusions. However, the data in Table 3 suggest that the materials produced under IQI guidelines produce the kind of performance the fleet requires, probably in less time than the present training. This should be tested.

Table 3
Student Performance (Unadjusted scores)
and Results of Covariate Analysis

	Standard	IQI	F
IQI Test Score (% correct)	49.1	57.0	6.07*
Mean Study Time (hours)	11.6 ^a	2.8	
Standard Deviation	5.2	1.0	

^aIncludes restudy time to reach RM school test criterion.

*p < .05.

DISCUSSION

IQI Analyses

Usability

The IQI provided a useful framework for critical examination of all elements of instructional design. If used in the manner intended, it takes the instructional designer step by step through all critical elements, which are not fully specified in the ISD process. The crux of the IQI analysis is ensuring that training and testing are relevant to the job. By forcing the designer to focus on job relevant behaviors, extraneous training and inappropriate testing are minimized.

In the present study, IQI analysis revealed areas where the current instruction did not provide adequate training or was otherwise faulty. For example, many objectives did not specify performance standards; thus, the degree of precision or the amount of time necessary for a given task had to be inferred. By following the stepwise IQI procedures, these deficiencies were readily identified. If the purpose of using the IQI is course revision, as in this case, redesign work can readily be directed to specific problem areas. On the other hand, if the purpose is course development, IQI techniques will aid in ensuring proper initial development and minimize further revision, independent of the particular training development method.

Problems Encountered

While the IQI manuals provide detailed guidance, some difficulties were encountered, particularly in determining the job relevancy of the objectives, the training materials, and

the testing designed to measure performance on the objectives. The IQI manuals direct the user to "remember the job" or to determine whether the objectives, etc., are appropriate to the initial work conditions; however, it is not clear where users are to obtain information about the job. If it is implied that course designers will have access to SME, this needs to be clarified. Also, other potential sources of job performance criteria need to be specified because of the difficulty in obtaining SMEs. Since training carries the connotation of ultimate job performance, the source(s) of this information needs to be fully explored.

Another difficulty may be inherent in IQI analysis; that is, because of the requirement for many small details, the designer may be distracted from the overall view of what the instruction is supposed to convey. Building the information bank from which the ultimate instruction is constructed can be a tedious process. For example, determining objective adequacy requires as many as 26 separate judgments. When there are a large number of objectives, this task can be overwhelming. It would be desirable to have the designer stand back from the stepwise process at regular intervals to integrate the many judgments with the overall process. When working with objectives, it is still necessary to ensure that they include all job relevant tasks.

An additional problem involved distinguishing use-aided tasks from unaided tasks. The IQI defined an aid as "anything that replaces the need for memory" However, this distinction was not sufficient to allow one team member to discriminate between aids and what the IQI terms "tools." For example, while the IQI manuals classify a list or a table as an aid, they classify the template used by an RM to verify spacing, etc., as a tool. While this may be a minor point, an educational specialist making this misclassification would then assign the wrong task level. This, in turn, would cause problems in determining the appropriateness of the objective and the consistency of the test items and instructional presentation.

Cost Considerations

The only nontrivial cost accruing to this application of IQI procedures was for lesson development; there was no need for additional hardware. Each team member took approximately 200 hours over a 5-month period to evaluate and revise objectives, evaluate and develop test materials, and revise course materials. The cost for this team was approximately 1/5 of a man-year. However, if IQI techniques were applied to instruction when it is initially developed by an experienced team, this cost should drop significantly.

Alternate Version Analysis

Since Instructional Program Development Center (IPDC) personnel considered the IQI revision as experimental, they initiated a parallel revision effort as part of an effort to modify the majority of the RM curriculum. As the two revision teams were using similar principles to modify the OCR module, a brief review of similarities and contrasts in execution is provided.

1. Objectives. The RM school has an equipment limitation that prevents training students in actually preparing (typing) OCR forms. However, the IQI team did develop objectives for form preparation requirements that called for memorization only, such as setting the typewriter tab stops and recalling constraints on constructing address components. The IQI objectives also included more complete standards for student performance, including both time to complete the task and required accuracy of the finished product. In other respects, the IQI and IPD sets of objectives were similar.

2. Test procedures.

a. The IPD and IQI end-of-module tests are identical, since they were developed as a joint effort. As indicated previously, test items consist of a completed OCR form; the student must select the portion of the form that contains an error.

b. The IPD intramodule tests, which are used as progress checks, are similar in format to the final module exam. However, testing is restricted to the particular lesson topic, which limits the number of alternatives on the form that can contain an error. In the IQI version, the student did not have to pass intramodule tests. Progress is checked by student self-tests.

3. Instructional presentation. Overall, the differences between the two versions are minor, although they involve slightly different levels of emphasis. In both, the objectives call for remembering facts and performing use-unaided procedures. However, the IPD version does not provide practice in remembering facts and, until the last section, does not provide practice in verifying steps. The IQI version instruction provides practice in both, and gradually reduces the prompts used to familiarize the student with the necessary steps. Specific differences that were found include:

a. The IPD version includes information not found in the IQI version, including a description of the difference between 10 and 12 pitch lettering, multiple page headerlines, a more complete description of template use, and information on readdressals without PSN numbers (some of this information was not available to the IQI team). Also, the IPD version provided better and more complete illustrations throughout. Because the IQI version was experimental in nature, it was not illustrated extensively in an attempt to reduce production time and costs.

b. The IQI version provides information missing in the standard version: better separation and identification of areas that must be correct before transmission can occur, information on the ZEN prosign, and nontest practice on checking OCR forms and readdressals.

CONCLUSIONS

The application of IQI facilitates the use of ISD procedures in ensuring job relevant instruction. It is especially useful in locating and preventing omissions by directing the user to examine all steps in instructional development. In this instance, instructional problems and errors were readily apparent.

Results of student performance on the IQI test indicate that higher levels of performance are possible in skills that are more directly applicable to fleet needs. Although better controls are needed to conclude whether acceptable fleet performance levels can be obtained efficiently, the evidence of this study indicates these standards can be met.

RECOMMENDATIONS

1. Since the IQI procedures provide a useful aid in developing instruction and in enhancing job-relevant training, they should be incorporated in Navy training development.

2. IQI procedures should be modified to provide the user with (a) better tools to deal with the job relevancy issue and (b) computer-based direction to aid in the many decisions that must be made in designing instruction.

3. Future evaluations of IQI applications should be conducted with control over learning and testing conditions for all groups so that information is provided for decision making.

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